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ON THE EFFECT OF CONTINUOUS SELECTION UPON TOBACCO; A PROGRESS REPORT

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INTRODUCTION

There are now grown in the Philippines several varieties of tobacco which have great possibilities for improvement. Unfortunately very few farmers select their seeds for planting and practically none of them practice selfing, so that many undesirable types are grown in this country, especially in the Cagayan Valley. Very recently the Bureau of Plant Industry has been able to standardize two varieties of tobacco, the native Vizcaya and Baker Sumatra, through selection and inbreeding. These varieties are now considered among the best in the Philippines.

Grown under shade, the native Vizcaya produces leaves suitable for wrapper, but grown in the open field, it produces a first class cigar filler and "batek" tobacco. The Baker Sumatra is a wrapper variety, now generally known locally by the name Ilagan Sumatra. It is considered better than its original stock because of the higher breadth index of the leaves.

The present report covers the results of continuous selection from the 1924–25 to the 1934–35 seasons, for both the cigar-wrapper and cigar-filler types of some of the standard varieties of tobacco, except for the varieties Espada and Romero which were included in this experiment three years later. No data are available for the 1928–29 and the 1930–31 tobacco seasons.

The investigation covered by this report was first conducted at the Ilagan Tobacco Station, Ilagan, Isabela, continued at the Alabang Rice Station in the 1932–33 season, and concluded in the 1933–34 and 1934–35 seasons at the Central Experiment Station, Manila.

The object of the investigation was to determine whether the breadth index of the leaves, the height of the plants, the number of standard leaves, and the yields in quintals per hectare can be improved by continuous selection.

REVIEW OF LITERATURE

According to Babcock and Claunsen(1), Johannsen, who made some studies on garden peas in 1901, found that selection within a single pure-line has no effect upon the improvement on the mean weights of the beans.

As reported by Hayes and Garber(6), Johannsen found that selection on beans and barley was futile.

Mendiola(9) made mention of the fact that the Philippine tobacco crop in general is not uniform, consequently the yield is low compared with those of other countries. He believes that the native tobacco varieties are only fitted for filler, binder, and for chewing purposes, but not for wrapper. But even for such purposes he believes that there is still need for improvement.

In 1922, Gutierrez(4) made several tobacco crosses, with the object of producing ideal cigar wrapper types. He pointed out that all the crosses were distinct improvements; that they have certain advantages over their parents in luxuriance, vigor, early maturity, size of leaves, rapidity of growth and other important characteristics. The same author(5) in his later work observed two hybrids nearly resistant to mosaic of tobacco, and he recommended for commercial wrapper production no less than six hybrid strains breeding true to types.

Fruwirth(3), who worked on lentil, vetch, snap bean, field pea, white mustard, and oats, found that pure-line selection does not change significantly the mean of the characters under study.

Hutcheson(7) in his thirteen years of continuous selection in wheat found that it has no significant effect.

Love and Craig(8) made a report that there is no evidence of selective effect on the height of oats.

MATERIALS AND METHOD

Standardization of varieties.—The imported varieties Baker Sumatra, Florida Sumatra, Adcock, Orinoco, and North Caro-

lina Bright Yellow, were first planted for at least two seasons for acclimatization. Then the best three plants from each variety were selected and selfed. The inflorescences were inclosed with paper bags in order to insure self-fertilization. In the following seasons they were planted head-to-the-row of from 10 to 150 plants each. This process was carried on for at least five seasons.

Types and varieties studied.—The following varieties were studied: (1) wrapper type—Baker Sumatra and Florida Sumatra; (2) cigar filler type—Pampano, Marogui, Repollo, Vizcaya, Espada, and Romero; (3) aromatic cigarette filler type—North Carolina Bright Yellow, Orinoco, and Adcock.

Characters studied.—The characters studied for each variety were the breadth index of the leaves, the height of the plants, the number of standard leaves, and the average yield per hectare. The breadth index of the leaves was determined by the width of the middle standard leaf divided by its length and multiplied by 100. The height of the plant was determined by measuring the plant from the base to the end of the inflorescence. Only leaves that measured 30 cm. or more in length were considered standard leaves. The average yield per hectare of marketable leaves was determined by computation (see results in Tables 1 to 4).

For each of the characters studied, the mean standard deviation and the coefficient of variability, including their probable errors, were computed by the standard method.

Cultural operations.—The seeds of each variety were sown in seed boxes. When the seedlings were about three weeks old, they were pricked in beds previously prepared. They were transplanted in the field when they were about seven or eight weeks old. The plants were cultivated at least three times in the field, where they were protected from insect pests by hand-picking of the worms and occasional dusting of the leaves with calcium arsenate. The leaves were harvested by priming and cured in curing sheds, with the exception of the aromatic cigarette-filler varieties which were partly cured in the sun.

DISCUSSION OF RESULTS

Breadth index of the leaves.—In the present study continuous selection seemed to have no significant effect on the mean of the breadth index of the leaves of tobacco, as shown in Table 1. This is true of all varieties studied. However, continuous selection did tend to have a beneficial effect on the standard deviation

and coefficient of variability of the breadth index of the leaves, although there was no continuous downward fall of the range of variation. Table 1 shows that the varieties Baker Sumatra, Pampano, Repollo, Vizcaya, Romero, North Carolina Bright Yellow, and Orinoco, had a high standard deviation in the first year of the experiment and have decreased in the season of 1934–35. In the case of the Espada variety the standard deviation has increased continuously from 3.05 ± 0.12 per cent in 1925–26 to 5.78 ± 0.62 per cent in 1934–35. In the Florida Sumatra variety the standard deviation was 6.00 ± 0.27 in 1924–25, increased to 9.22 ± 0.39 in 1926–27, decreased to 3.66 ± 0.34 in 1933–34, and again increased to 9.24 ± 0.99 in 1934–1935. In the Adcock variety also there was essentially a decrease in standard deviation, for in 1927–28 it was 6.40 ± 0.97 and in 1934–35 it decreased to 4.12 ± 0.44, while in 1933–34 it increased to 8.84 ± 0.84.

The varieties Baker Sumatra, Repollo, Vizcaya, and North Carolina Bright Yellow showed a marked decrease also in their standard deviations. In the season of 1924–25 the variety Baker Sumatra has a standard deviation of 6.75 ± 0.31 and in 1934–35 it decreased to 2.21 ± 0.24.

With the cigarette-filler varieties there was a decrease in standard deviation. For instance, the variety North Carolina Bright Yellow, which had a standard deviation of 10.92 ± 1.35 in the 1927–28 season, had a standard deviation of only 4.86 ± 0.58 in 1934–35.

Height of the plants.—Table 2 shows that in general the height of the plants was not improved by continuous selection. At certain seasons the plants attained a considerable height, but at other seasons they decreased in height. In other words, the average height of the plants was quite variable in different seasons. This is true especially with the varieties Baker Sumatra, Florida Sumatra, Pampano, Marogui, Repollo, and Vizcaya. In the case of Repollo the standard deviation was 25.74 ± 1.23 in the 1924–25 season and decreased to 21.31 ± 2.27 in 1934–35. On the other hand the variety Vizcaya had a standard deviation of 27.34 ± 2.14 in 1924–25 and increased to 38.25 ± 4.08 in 1934–35.

The variation of the mean, standard deviation, and the coefficient of variability for all of the varieties investigated, are very great, as shown in the same table. For example, the variety Baker Sumatra has a range of variation in height of from 80 to 190 cm. in 1924–25, 135 to 245 cm. in 1927–28, and 171 to

210 cm. in 1934–35. This is also true of the variety Pampano of the cigar-filler type. In 1924–25 this variety has a range of height of from 100 to 220 cm., in 1927–28 it increased to 245–285 centimeters, but in 1934–35 it decreased to 161–270 cm. In the case of the aromatic cigarette-filler type, taking North Carolina Bright Yellow as an example, the range is 105 to 165 cm. in 1927–28. The range has increased to 131–180 cm. in 1934–35.

If we base our comparison on the results of the 1924–25, 1925–26, and 1934–35 seasons it will be noted in Table 2 that there was an increase in height for all of the varieties. The difference in height of the plants of different seasons, according to our observations, is due to weather conditions. Baker Sumatra had a mean height of 103.61 ± 3.88 cm. in 1924–25. In 1934–35 its height increased to 181.0 ± 0.43 cm. Florida Sumatra increased from 143.98 ± 1.19 cm. in the 1924–25 season to 159.0 ± 2.88 cm. in the 1934–35 season. During the same period the cigar-filler varieties also increased in height. Pampano increased from 157.51 ± 1.77 cm. to 222.5 ± 4.08 cm., Marogui from 158.23 ± 0.16 cm. to 206.3 ± 4.65 cm., Repollo from 151.7 ± 1.72 cm. to 237.0 ± 3.21 cm., Vizcaya from 154.23 ± 3.93 cm. to 202.5 ± 5.77 cm., Espada from 154.67 ± 0.13 cm. to 243.0 ± 3.39 cm., and Romero 138.3 ± 1.32 cm. to 189.0 ± 1.82. Similarly the aromatic cigarette varieties also increased in height from 1927–28 season to the 1934–35 season. North Carolina Bright Yellow increased from 130.3 ± 3.29 to 144.8 ± 1.98 cm., Orinoco from 116.6 ± 1.19 cm. to 119.3 ± 1.68 cm., and Adcock from 130.0 ± 5.33 cm. to 151.0± 2.19 cm.

Number of standard leaves.—One of the most important features of this study is the number of standard leaves because these are the parts which are used in commerce. Table 3 shows that selection has no advantageous effect upon the number of standard leaves. Like height, the number of standard leaves invariably increased in one season and decreased in another season. Nevertheless, if the results of the first and last seasons are to be used as basis of comparison, as in the case of height, there will be noted an increase in the number of standard leaves for all the varieties studied except Orinoco. As a rule, the number of standard leaves would depend upon the vigor of the plants. Under more favorable climatic conditions we would expect a better stand and more standard leaves per plant. The number of standard leaves in Baker Sumatra increased from 22.01 ± 0.21 in 1924–25 to 27.80 ± 0.34 in 1934–35, in Florida

Sumatra from 20.42 ± 0.07 to 31.1 ± 0.58, in Pampano, from 22.25 ± 0.24 to 30.1 ± 0.46, in Marogui from 22.56 ± 0.21 to 33.22 ± 1.01, in Repollo from 24.15 ± 0.27 to 30.30 ± 0.65, in Romero from 13.72 ± 0.09 to 22.6 ± 0.24, in North Carolina Bright Yellow from 21.07 ± 0.49 to 22.76 ± 0.34, and in Adcock from 21.80 ± 0.70 to 25.9 ± 0.31.

The same table shows that there is no significant decrease in the standard deviation. The range of variation was generally wide, and the standard deviation was great, for when the range of variation is small the standard deviation is correspondingly small. This was best illustrated by Baker Sumatra. In the 1933–34 season the range of variation in the number of leaves of this variety was only from 23 to 30 leaves. Hence, its standard deviation was comparatively small, being 1.64 ± 0.16. On the other hand in the 1924–25 season the range of variation of the same variety was great, from 14 to 32 leaves, so that the standard deviation was also high, 3.16 ± 0.15. This is true with all the varieties studied.

The means and standard deviation of the varieties under study were quite variable at different seasons. The variety Baker Sumatra had a mean of 26.36 ± 0.22 leaves in the 1933–34 season with a standard deviation of 1.64 ± 0.16 leaves; Florida Sumatra 31.9 ± 0.24 in 1927–28 season with a standard deviation of 1.61 ± 0.17; Pampano 29.2 ± 0.34 in the 1927–28 season with a standard deviation of 1.60 ± 0.24; Repollo 26.12 ± 0.18 in 1926–27 with a standard deviation of 1.93 ± 0.13; Romero 22.6 ± 0.24 in 1934–35 with a standard deviation of 1.56 ± 0.17 and North Carolina Bright Yellow 22.76 ± 0.34 in 1934–35 with a standard deviation of 2.01 ± 0.24.

Yield in quintals per hectare.—Judging by the results obtained for two seasons, as shown in Table 4, continuous selection has a favorable effect upon yield per hectare. Previous to the 1933–34 season we have no records on yield per hectare. With the exception of the Florida Sumatra, Marogui, and Vizcaya varieties, there may be seen an improvement in the yield during the 1934–35 season over that of the 1933–34 season. Baker Sumatra had a mean yield of 14.94 ± 0.41 quintals per hectare in 1933–34 and increased to 15.5 ± 0.50 quintals. In the 1934–35 season Pampano increased from 25.9 ± 0.79 to 30.7 ± 1.07, Repollo from 36.26 ± 0.82 to 40.3 ± 1.62, Espada from 34.7 ± 0.80 to 38.7 ± 0.80 to 38.7 ± 1.32, Romero from 15.0 ± 0.32 to 25.6 ± 0.89, North Carolina Bright Yellow from 16.6 ± 0.50

to 24.62 ± 1.24, Orinoco from 19.68 ± 0.61 to 35.18 ± 1.79 quintals, and Adcock from 18.7 ± 0.57 to 31.8 ± 1.19 quintals.

The same table shows that the coefficient of variabilities is high due to the high standard deviations and low means. The coefficient of variability, being the ratio of the standard deviation and the mean multiplied by 100 per cent, will naturally be high.

Table 4 shows also that the range of variation in yield of the varieties Baker Sumatra, Pampano, Repollo, and Espada is not very significant. The reverse is true in the case of the varieties Florida Sumatra, Marogui, Vizcaya, Romero, North Carolina Bright Yellow, Orinoco, and Adcock.

SUMMARY AND CONCLUSION

1. The application of continuous selection in tobacco production has generally no advantageous effect on the mean of the breadth index of the leaves, the height of plants, and the number of standard leaves.

2. The results of the 1934–35 season shows, with respect to the wrapper varieties, that Florida Sumatra produced a greater number of standard leaves than Baker Sumatra or 31.1 ± 1.01. The Marogui produced the highest number of standard leaves among the cigar filler varieties being 33.22 ± 1.01. In the case of the aromatic cigarette varieties, Adcock produced the greatest number of standard leaves, which is 25.9 ± 0.31.

3. Continuous selection resulted in the increased yield of the following varieties of tobacco: Sumatra, Pampano, Repollo, Espada, Romero, North Carolina Bright Yellow, Orinoco, and Adcock. But since these results are based on two seasons only they can not be considered conclusive.

4. The cigar-wrapper variety Baker Sumatra gave a higher yield per hectare than Florida Sumatra, which is 15.5 ± 0.50 quintals. Among the cigar-filler varieties, Repollo gave the highest average yield or 40.3 ± 1.62 quintals per hectare. In the case of the aromatic cigarette varieties, Orinoco gave the highest yield, which is 35.18 ± 1.79 quintals.

5. The range of variation in the yield per hectare of the varieties Baker Sumatra, Pampano, Repollo, and Espada is not significant.

6. Standard deviation and coefficient of variability are directly proportional to the range of variation in any character.

7. The difference in the results obtained for the different seasons of any single variety is largely due to the existing climatic conditions. The climatic conditions at certain seasons are more favorable for the crop than other seasons.

8. The present results conform to the findings of previous investigations.

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Table I.—*Statistical data on breadth index of leaves*

VARIETY—BAKER SUMATRA

Season grown	Range of variation	Total	Mean	Standard deviation	Coefficient of variability
1924–25	50–80	105	56.88± .44	6.75± .31	12.04± .56
1925–26	42–82	150	56.43± .35	6.35± .25	11.25± .44
1926–27	----------	--------	53.50± .25	3.74± .18	6.99± .33
1927–28	52–68	20	59.75± .61	4.02± .43	6.73± .72
1933–34	50–75	25	58.32± .63	4.69± .45	8.04± .77
1934–35	50–59	20	56.3 ± .33	2.21± .24	3.09± .33

TABLE I.—*Statistical data on breadth index of leaves*—Continued

VARIETY—FLORIDA SUMATRA

Season grown	Range of variation	Total	Mean	Standard deviation	Coefficient of variability
1924–25	55–85	104	59.43± .40	6.00± .27	10.10± .47
1925–26	37–97	150	64.13± .47	8.69± .34	13.55± .54
1926–27			60.00±1.97	9.22± .39	15.73±2.37
1927–28	62–78	20	69.00± .76	5.03± .54	7.28± .78
1933–34	50–65	25	58.00± .49	3.66± .34	6.32± .60
1934–35	52–87	20	60.8 ±1.39	9.24± .99	15.11±1.64
VARIETY—PAMPANO					
1924–25	45–80	103	54.45± .56	8.51± .41	15.60± .73
1925–26	42–77	103	58.45± .08	1.16± .06	1.91± .09
1926–27			62.75± .78	7.33± .55	11.67± .89
1927–28		10	62.00±1.01	4.72± .71	7.61±1.15
1933–34	36–57	25	50.08± .49	3.64± .35	17.27± .69
1934–35	40–69	20	52.7 ± .84	5.58± .60	10.58±1.13
VARIETY—MAROGUI					
1924–25	45–70	101	48.48± .04	4.26± .19	18.78± .33
1925–26	37–57	100	47.9 ± .23	3.37± .16	7.05± .34
1926–27			49.60± .56	5.92± .40	11.94± .82
1927–28	42–53	15	49.17± .52	2.99± .37	6.07± .75
1933–34	42–57	25	49.44± .36	2.74± .26	5.55± .53
1934–35	43–54	19	48.38± .39	2.54± .28	5.25± .57
VARIETY—REPOLLO					
1924–25	40–70	100	46.20± .42	6.23± .30	13.53± .65
1925–26	37–52	100	41.15± .21	3.12± .15	7.55± .36
1926–27			41.20±3.45	3.85± .26	9.58± .65
1927–28	37–58	25	44.7 ±1.60	4.47±1.13	10.00± .95
1933–34	38–55	25	46.96± .49	3.67± .35	7.81± .74
1934–35	48–55	20	50.5 ± .27	1.77± .19	3.50± .37
VARIETY—VIZCAYA					
1924–25	40–70	37	45.73± .58	5.20± .41	11.36± .89
1925–26	42–62	100	46.75± .31	4.53± .22	9.69± .46
1926–27			50.90± .71	5.24± .50	10.3 ± .99
1927–28	42–58	15	49.83± .58	3.32± .41	6.67± .82
1933–34	40–59	25	43.76± .44	3.26± .31	7.45± .71
1934–35	36–47	20	43.4 ± .45	2.96± .32	6.85± .73
VARIETY—ESPADA					
1925–26	32–47	150	36.43± .17	3.05± .12	8.37± .33
1926–27			37.83± .59	3.40± .42	8.99±1.11
1927–28	37–48	10	42.00± .75	3.50± .53	8.33±1.28
1933–34	30–53	25	41.92± .62	4.61± .43	11.00±1.16
1934–35	39–58	20	45.2 ± .87	5.78± .62	12.79±1.37
VARIETY—ROMERO					
1925–26	42–82	100	64.73± .48	7.12± .34	10.96± .53
1926–27			55.00± .05	.25± .04	.45± .07
1927–28	42–58	15	53.5 ± .79	4.55± .56	8.50±1.05
1933–34	37–76	25	55.48± .81	6.02± .57	10.84±1.04
1934–35	47–62	20	55.7 ± .58	3.86± .41	6.93± .74

TABLE I.—*Statistical data on breadth index of leaves*—Continued

VARIETY—NORTH CAROLINA BRIGHT YELLOW

Season grown	Range of variation	Total	Mean	Standard deviation	Coefficient of variability
1927–28	42–68	15	54.50±1.90	10.92±1.35	20.04±2.56
1931–32	45–70	25	56.20± .78	5.85± .55	10.41±1.00
1932–33	39–56	25	47.32± .50	3.73± .35	7.89± .75
1933–34	43–66	24	58 ± .61	4.47± .43	7.71± .75
1934–35	44–59	16	49.9 ± .82	4.86± .58	9.74±1.16
VARIETY—ORINOCO					
1927–28	32–48	25	38.30± .65	4.83± .46	12.62±1.22
1931–32	27–40	25	32.36± .38	2.86± .27	8.86± .84
1932–33	28–45	25	33.44± .49	3.64± .34	10.89±1.05
1933–34	36–51	25	37.2 ± .58	4.28± .40	11.52±1.11
1934–35	30–43	17	34.46± .52	3.16± .37	9.11±1.05
VARIETY—ADCOCK					
1927–28	37–58	10	49.50±1.37	6.40± .97	12.94±1.98
1931–32	37–50	25	42.68± .51	3.82± .36	8.95± .85
1932–33	40–59	25	49.84± .47	3.52± .33	7.08± .67
1933–34	43–78	25	54.92±1.19	8.84± .84	16.10±1.57
1934–35	35–56	20	46.6 ± .62	4.12± .44	8.84± .94

TABLE II.—*Statistical data on height of plants*

VARIETY—BAKER SUMATRA

Season grown	Range of variation	Total	Mean	Standard deviation	Coefficient of variability
1924–25	80–190	103	103.61±3.88	24.74± 2.74	18.94±2.11
1925–26	115–245	150	178.20±1.50	27.28± 1.06	15.31± .61
1926–27			144.20± .81	12.06± .58	8.36± .40
1927–28	135–245	20	196.50±3.73	24.75± 2.64	12.59±1.36
1933–34	121–240	25	207.8 ±3.12	23.2 ± 2.21	11.16±1.07
1934–35	171–210	20	181.0 ± .43	9.49± 1.01	5.24± .60
VARIETY—FLORIDA SUMATRA					
1924–25	120–210	104	143.98±1.19	18.08± .84	12.55± .59
1925–26	115–235	150	157.27±1.10	20.05± .78	12.75± .50
1926–27			123 ±3.90	18.33± 2.77	14.91±2.30
1927–28	125–225	20	184 ±3.78	25.08± 2.67	13.63±1.48
1933–34	121–260	25	213 ±4.26	31.62± 3.01	14.85±1.44
1934–35	111–190	20	159 ±2.88	19.13± 2.04	12.03±1.30
VARIETY—PAMPANO					
1924–25	100–220	103	157.51±1.77	26.65±12.52	16.92±7.93
1925–26	135–225	100	169.80±1.16	17.25± .82	10.11± .49
1926–27			161.75±2.04	20.05± 1.51	12.43± .95
1927–28	245–285	10	271.00±3.05	14.28± 2.15	5.27± .79
1933–34	191–250	25	220.6 ±1.78	13.25± 1.26	6.00± .57
1934–35	161–270	20	222.5 ±4.08	27.07± 2.89	12.17±1.32

TABLE II.—*Statistical data on height of plants*—Continued

Season grown	Range of variation	Total	Mean	Standard deviation	Coefficient of variability
VARIETY—MAROGUI					
1924-25	100-230	101	158.23 ± .16	2.38 ± .11	1.51 ± .07
1925-26	125-205	100	161.20 ±1.08	16.06 ± .76	9.97 ± .48
1926-27			151.80 ±2.09	21.86 ± .48	14.41 ± .99
1927-28	185-285	15	234.30 ±4.96	28.51 ± 3.51	12.17 ±1.52
1933-34	201-260	25	227.8 ±1.78	13.25 ± 1.26	5.81 ± .55
1934-35	141-260	19	206.3 ±4.65	30.03 ± 3.85	14.56 ±1.63
VARIETY—REPOLLO					
1924 25	110-240	100	151.70 ±1.72	25.74 ± 1.23	16.29 ± .78
1925 26	115-215	100	168.10 ±1.46	21.65 ± 1.03	12.88 ± .62
1926-27			144.50 ±1.82	19.07 ± 1.29	13.20 ± .91
1927-28	245-235	25	285.00 ±3.43	25.46 ± 2.43	8.93 ± .85
1933-34	111-270	25	199.4 ±4.51	33.44 ± 3.19	16.77 ±1.64
1934-35	181-280	20	237.0 ±3.21	21.31 ± 2.27	8.99 ±9.59
VARIETY—VIZCAYA					
1924-25	110-210	37	154.23 ±3.93	27.34 ± 2.14	17.71 ±1.09
1925 26	115-225	100	159.30 ±1.26	18.63 ± .88	11.06 ± .53
1926-27			143.80 ±2.75	20.46 ± 1.95	14.23 ±1.38
1927-28	215-275	15	243.70 ±3.15	18.09 ± 2.23	7.39 ± .91
1933-34	171-240	25	200.55 ±2.54	17.67 ± 1.79	8.81 ± .89
1934-35	121-250	20	202.5 ±5.77	38.25 ± 4.08	18.89 ±2.09
VARIETY—ESPADA					
1925-26	115-215	150	154.67 ± .13	20.47 ± .80	13.24 ± .59
1926-27			159.67 ±3.91	22.48 ± 2.77	14.14 ±1.77
1927-28	195-255	10	230.00 ±4.18	19.62 ± 2.96	8.53 ±1.29
1933-34	111-270	25	209 ±4.91	36.4 ± 3.47	17.41 ±1.75
1934-35	181-280	20	243.0 ±3.39	22.49 ± 2.40	9.26 ± .99
VARIETY—ROMERO					
1925-26	85-185	100	138.30 ±1.32	19.64 ± .94	14.20 ± .68
1926-27			97.00 ± .05	21.82 ± 3.29	22.55 ±3.57
1927-28	145-205	15	173.70 ±3.24	18.61 ± 2.29	10.71 ±1.33
1933-34	141-220	25	181.00 ±2.26	16.73 ± 1.59	9.24 ± .88
1934-35	161-220	20	189.00 ±1.82	12.08 ± 1.29	6.39 ± .68
VARIETY—NORTH CAROLINA BRIGHT YELLOW					
1927 28	105-165	15	130.30 ±3.29	18.87 ± 2.32	14.48 ±1.82
1931-32	61-100	25	75.40 ±1.52	11.34 ± 1.08	15.04 ±1.46
1932-33	100-160	25	127.80 ±2.15	15.92 ± 1.52	12.48 ± .61
1933-34	91-180	25	138.6 ±2.48	18.39 ± 1.75	13.26 ±1.28
1934-35	131-180	16	144.8 ±1.98	11.77 ± 1.40	8.13 ± .97
VARIETY—ORINOCO					
1927-28	95-135	25	116.60 ±1.19	8.80 ± .84	7.55 ± .72
1931-32	61-100	25	74.20 ±1.12	8.35 ± .79	11.25 ±1.08
1932-33	95-150	25	114.40 ±1.80	13.37 ± 1.28	11.44 ± .56
1933-34	41-140	25	93.0 ±3.81	28.28 ± 2.69	30.41 ±3.15
1934-35	101-150	17	119.3 ±1.68	10.25 ± 1.19	8.59 ± .99

TABLE II.—*Statistical data on height of plants*—Continued

VARIETY—ADCOCK

Season grown	Range of variation	Total	Mean	Standard deviation	Coefficient of variability
1927–28	105–175	10	130.00±5.33	25.00± 3.77	19.24± .29
1931–32	91–130	25	104.60±1.36	10.15± .96	9.70± .92
1932–33	115–155	25	130.00±1.33	9.88± .94	7.60± .37
1933–34	101–160	25	128.24±1.93	14.28± 1.36	11.13±1.07
1934–35	111–180	20	151.0 ±2.19	14.49± 1.55	9.60±1.02

TABLE III.—*Statistical data on number of standard leaves*

VARIETY—BAKER SUMATRA

Season grown	Range of variation	Total	Mean	Standard deviation	Coefficient of variability
1924–25	14–32	105	22.01±0.21	3.16±0.15	14.34±0.67
1925–26	12–26	150	19.09± .12	2.25± .09	11.64± .46
1926–27			16.84± .10	1.47± .07	8.75± .42
1927–28	22–30	20	25.20±1.09	2.14± .23	8.47± .90
1933–34	23–30	25	26.36± .22	1.64± .16	6.22± .59
1934–35	25–32	20	27.8 ± .34	2.23± .24	8.01± .86
VARIETY—FLORIDA SUMATRA					
1924–25	16–28	104	20.42± .07	1.04± .05	5.08± .24
1925–26	12–24	150	19.29± .13	2.38± .09	12.78± .51
1926–27			18.20± .40	1.89± .28	10.37±1.58
1927–28	30–36	20	31.90± .24	1.61± .17	5.04± .54
1933–34	19–32	25	26.84± .39	2.93± .27	10.93±1.05
1934–35	22–37	20	31.1 ± .58	3.82± .41	12.28±1.31
VARIETY—PAMPANO					
1924–25	14 34	103	22.25± .24	3.62± .17	11.76± .55
1925–26	14–26	100	19.94± .16	2.37± .11	11.95± .58
1926–27			20.90± .23	2.19± .17	10.47± .80
1927–28	26–32	10	29.2 ± .34	1.60± .24	5.48± .83
1933–34	19 38	25	28.12± .45	3.35± .32	11.91±1.15
1934 35	21 36	20	30.1 ± .46	3.06± .33	10.18±1.64
VARIETY—MAROGUI					
1924 25	18 34	101	22.56± .21	3.09± .15	13.69± .65
1925–26	16–32	100	22.94± .02	3.21± .15	14.06± .68
1926 27			28.36± .26	2.74± .18	9.64± .65
1927–28	34–46	15	41.33± .67	3.84± .47	9.28±1.44
1933–34	25–36	25	29.48± .33	2.45± .23	8.31± .79
1934–35	21–42	19	33.22±1.01	6.60± .71	19.55 ±2.23
VARIETY—REPOLLO					
1924–25	16–28	100	24.15± .27	3.98± .19	16.40± .77
1925–26	18–32	100	23.72± .16	2.43± .12	10.68± .48
1926–27			26.12± .18	1.93± .13	7.37± .50
1927–28	34–50	25	42.80± .54	3.99± .38	9.32± .89
1933–34	22–49	25	34.4 ± .86	6.4 ± .61	18.60±1.83
1934–35	25–38	20	30.3 ± .65	4.30± .65	14.20±1.51

TABLE III.—*Statistical data on number of standard leaves*—Continued

Season grown	Range of variation	Total	Mean	Standard deviation	Coefficient of variability
VARIETY—VIZCAYA					
1924-25	18-26	37	20.48± .23	2.08± .16	13.69±1.07
1925-26	16-28	100	20.80± .19	2.88± .14	13.87± .67
1926-27			24.08± .53	3.93± .38	16.30±1.6
1927-28	36-46	15	41.20± .62	3.56± .44	8.65±1.06
1933-34	32-49	25	39.00± .63	4.43± .45	11.37±1.17
1934-35	17-36	20	28.4 ± .72	4.78± .51	16.83±1.80
VARIETY—ESPADA					
1925-26	18-26	150	21.92± .14	2.45± .10	11.19± .49
1926-27			25.34± .45	2.59± .32	10.23±1.27
1927-28	30-40	10	35.20± .61	2.86± .43	8.11±1.22
1933-34	20-53	25	39.68± .96	7.14± .68	18.01±1.77
1934-35	25-42	20	33.0 ± .51	4.82± .51	14.59±1.59
VARIETY—ROMERO					
1925-26	8-24	100	13.72± .09	1.42± .07	10.32± .50
1926-27			12.80± .21	.98± .15	7.66±1.16
1927-28	16-20	15	18.53± .24	1.36± .17	7.32± .90
1933-34	17-24	25	20.44± .19	1.44±1.37	7.06± .68
1934-35	20-27	20	22.6 ± .24	1.56± .17	6.90± .74
VARIETY—NORTH CAROLINA BRIGHT YELLOW					
1927-28	14-24	15	21.07± .49	2.82± .35	13.37±1.68
1931-32	7-16	25	9.80± .38	2.82± .26	28.85±2.97
1932-33	14-24	25	19.10± .35	2.57± .24	13.45± .77
1933-34	17-26	25	20.52± .27	2.06± .19	10.04± .96
1934-35	20-29	16	22.76± .34	2.01± .24	8.84±1.05
VARIETY—ORINOCO					
1927-28	30-42	25	34.56± .44	3.22± .31	9.33± .89
1931-32	10-25	25	16.32± .15	1.40± .13	8.61± .82
1932-33	16-36	25	25.36± .49	3.65± .35	14.39± .71
1933-34	15-32	25	25.96± .56	4.16± .39	16.03±1.56
1934-35	18-27	17	21.66± .41	2.51± .29	11.88±1.39
VARIETY—ADCOCK					
1927-28	16-26	10	21.80± .70	3.28± .50	15.05± .93
1931-32	8-17	25	11.35± .34	2.57± .24	22.65±2.26
1932-33	16-30	25	23.36± .48	3.58± .34	15.32± .76
1933-34	11-24	25	17.88± .36	2.67± .25	14.95±1.45
1934-35	20-31	20	25.9 ± .31	2.05± .22	7.90± .84

TABLE IV.—*Statistical data on yield in quintals*[1]

[Per Hectare]

Season grown	Range of variation	Total	Mean	Standard deviation	Coefficient of variability
VARIETY—BAKER SUMATRA					
1933–34	12–21	19	14.94±0.41	2.68±0.29	17.95±2.02
1934–35	11–26	20	15.5 ± .50	3.34± .36	21.55±2.39
VARIETY—FLORIDA SUMATRA					
1933–34	17–28	20	21.5 ± .40	2.67± .28	12.32±1.34
1934–35	9–24	20	13.2 ± .45	2.96± .32	22.42±2.51
VARIETY—PAMPANO					
1933–34	19–38	20	25.9 ± .79	5.27± .56	20.34±2.26
1934–35	18–43	20	30.7 ±1.07	7.11± .76	23.16±2.59
VARIETY—MAGOGUI					
1933–34	26–45	18	36.56± .83	5.20± .58	14.22±1.63
1934–35	16–43	19	32.44± .99	6.43± .70	19.51±2.22
VARIETY—REPOLLO					
1933–34	25–46	19	36.26± .82	5.31± .58	14.64±1.63
1934–35	23–60	20	40.3 ±1.62	10.76±1.15	26.69±3.05
VARIETY—VIZCAYA					
1933–34	29–42	19	34.26± .54	3.50± .38	10.21±1.12
1934–35	11–56	20	31.7 ±1.74	11.56±1.23	36.46±4.36
VARIETY—ESPADA					
1933–34	25–44	20	34.7 ± .80	5.30± .57	15.27±1.66
1934–35	27–58	20	38.7 ±1.32	8.74± .93	22.58±2.53
VARIETY—ROMERO					
1933–34	11–20	20	15.0 ± .32	2.09± .22	13.93±1.50
1934–35	16–45	20	25.6 ± .89	5.88± .63	22.97±2.57
VARIETY—NORTH CAROLINA BRIGHT YELLOW					
1933–34	14–27	20	16.6 ± .50	3.29± .35	19.82±2.19
1934–35	16–43	16	24.62±1.24	7.36± .88	29.89±3.85
VARIETY—ORINOCO					
1933–34	13–28	18	19.68± .61	3.85± .43	19.56±2.29
1934–35	20–55	17	35–18±1.79	10.98±1.27	31.21±3.93
VARIETY—ADCOCK					
1933–34	12–27	20	18.7 ± .57	3.81± .41	20.37±2.26
1934–35	20–51	20	31.8 ±1.19	7.89± .84	24.81±2.81

[1] One quintal is equivalent to 50 kilograms instead of 46 in this particular case, since it is the one being used for tobacco in commerce.

STUDIES ON THE CONTROL OF ABACÁ BUNCHY-TOP WITH REFERENCE TO VARIETAL RESISTANCE [1]

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THREE PLATES AND ONE TEXT FIGURE

INTRODUCTION

The persistent desire of farmers to revive the once profitable abacá industry in Cavite, Batangas, and Laguna, after the bunchy-top disease had wiped out the industry completely several years ago, formed the basis of this investigation on resistant varieties. The work reported herein was started during the later part of 1928 and has been continued up to the present. Preliminary results published by the senior author (1931) in the *Philippine Journal of Agriculture* held out little hope of finding a desirable variety of abacá that is absolutely immune to bunchy-top.

In Australia, where bunchy-top was reported to be a serious disease of banana, the investigating committee concluded "that no resistant or immune banana stock is available" (Anon. 1925, 1926). Gadd (1925), in his observation on a plot of plantains affected by bunchy-top disease at Peradeniya Experiment Station in Ceylon, states that none of the banana varieties used in his tests are immune to the disease. Mendiola and Ocfemia (1926) believe that varieties of abacá resistant to diseases may be produced by cross-pollination. According to Ocfemia (1931) all varieties of abacá used in his experiment at Los Baños, Laguna, "including first generation variety hybrids are infected by bunchy-top in the same degree."

During the first two years of experimentation in Silang, Cavite, the search for a resistant or immune variety, even among the ten introduced commercial varieties of abacá produced no tangible results. In the course of time, however, some of the introduced varieties, besides becoming well adapted to the local-

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ity, have seemingly developed a certain degree of resistance to bunchy-top. Others, however, that exhibited slight resistance, became more susceptible and have succumbed to the disease. It is evident, therefore, that although the abacá varieties introduced at the Experiment Station were all attacked by bunchy-top, certain varieties are much more readily affected than others. This variation in the degree of susceptibility has offered a basis for isolating and propagating certain varieties of abacá highly resistant to bunchy-top, as will be shown here subsequently.

This paper presents the results of further studies on selection and propagation of highly resistant varieties and the roguing of diseased plants as a means of control.

MATERIALS AND METHODS

The investigation reported in this paper was performed in an abandoned abacá field that was once a flourishing plantation in Silang, Cavite, but had been entirely wiped out by bunchy-top disease. This piece of land consists of about 5 hectares, but only a selected portion of approximately 3 hectares was used for experimentation. In preparing the land the big shade trees were heavily pruned, the underbrush was cut down, and all diseased abacá plants were completely dug up and burned. Before planting, stakes were laid out in rows at a distance of 3 meters each way and the holes were dug about 8 to 10 inches deep and approximately 10 inches in diameter.

In the infection experiments natural and artificial methods were used.

Introduced abacá varieties.—The different varieties of abacá used in the preliminary experiment were collected from the different abacá growing localities in the Philippines since 1924 by the former Bureau of Agriculture. These varieties are (1) Balunan, (2) Baluñganon, (3) Jolo, (4) Lawisid, (5) Maguindanao, (6) Punucan, (7) Putian, (8) Sinamoro Pula, (9) Sinamoro Puti, and (10) Tañgoñgon. They were first planted at the old Abacá Disease Experiment Station in Sabutan, Silang, Cavite, where they have been grown for about four years. In the later part of 1928 healthy suckers of each variety were selected and shipped to the new Abacá Experiment Station in Viluso, Silang, Cavite. They were planted separately in rows, one rootstock or sucker to a hill, with their corresponding labels,

Field observations were made from December, 1928 to December, 1930, with particular emphasis on the behavior of each variety. The criteria for selection were: (1) varietal reaction to bunchy-top infection under field conditions, (2) local adaptability, and (3) quality of fibers.

After about two years of field observation, the senior author (1931), in a preliminary test along the lines of varietal resistance, found that the Putian variety was highly resistant to bunchy-top disease. It was further observed that among the 10 abacá varieties introduced at the Silang Experiment Station, the Putian variety is best adapted to the local conditions. The quality of the fiber is also fairly good. For these three reasons the Putian variety was the only one selected and propagated on a large scale for further trials. The other 9 introduced abacá varieties (Balunan, Baluñganon, Jolo, Lawisid, Maguindanao, Punucan, Sinamoro Pula, Sinamoro Puti, and Tañgoñgon) were eliminated in this experiment because they fell short of our standard measurements. One of the highly susceptible introduced varieties of abacá is illustrated in Plate 2, fig. 2.

Local abacá varieties.—The local varieties used in this investigation consist of the remnants of those that appeared to have withstood the attack of bunchy-top in Silang, Cavite. These varieties are: (1) Sinibuyas and (2) Kinalabao. Only healthy suckers of these two varieties were collected and planted in separate plots in the station.

EXPERIMENTS AND RESULTS

PROPAGATION OF THREE SELECTED VARIETIES OF ABACÁ AND THEIR RELATION TO BUNCHY-TOP DISEASE

Experiment 1.—On June 15, 1930, Lot B (75 meters long by 36 meters wide) was prepared adjacent to Lot A which was already planted to 155 healthy rootstocks of the local Kinalabao variety. Lot C (75 meters long and 75 meters wide) was simultaneously prepared adjacent to Lot B . Lot B was planted to 288 healthy rootstocks of the Putian variety. Lot C was planted to 570 well selected rootstocks of the local Sinibuyas variety. In other words, the Putian variety (Lot B) is between the Kinalabao (Lot A) and the Sinibuyas (Lot C). Field observations were made commencing in November, 1930, up to August, 1934. The results obtained are summarized in Table 1.

TABLE 1.—*Results of about 4 years' observations on the three selected varieties of abacá (Putian, Sinibuyas, and Kinalabao) showing varying degrees of resistance to bunchy-top disease under field condition at Viluso, Silang Experiment Station.*

Name of variety	Total number of plants		Percentage of bunchy-top infection
	Planted	Infected	
Kinalabao (Lot A)	155	37	23.87
Putian (Lot B)	288	10	3.47
Sinibuyas (Lot C)	570	47	8.24

It is evident from Table 1 that the three selected varieties used in this experiment showed varying degrees of infection to bunchy-top. The introduced Putian variety excelled both the local Sinibuyas and the Kinalabao varieties in resistance to the disease. (See illustration on Plate 1.) As low as 3.47 per cent infection was obtained in the case of the Putian variety, while in the case of the Kinalabao and the Sinibuyas the infections were 23.87 per cent and 8.24 per cent, respectively. In other words, the Putian variety is almost 96 per cent resistant to bunchy-top; the local Sinibuyas, 92 per cent; and the Kinalabao, 77 per cent.

Experiment 2.—The above experiment was repeated in July, 1934. Instead of being planted in three separate lots, the three varieties were planted in alternate rows, 3 meters apart each way. The first row was planted to Kinalabao; the second, to Sinibuyas; the third, to Putian; etc., etc. Regular observations were made from the date of planting to January, 1935. The results are shown in Table 2.

TABLE 2.—*Results of observations on three selected varieties of abacá (Kinalabao, Sinibuyas, Putian) planted in alternate rows, at Viluso, Silang Experiment Station, showing the percentage of bunchy-top infection under natural field conditions.*

Name of variety	Total number of plants		Percentage of bunchy-top infection
	Planted	Infected	
Kinalabao	84	16	19.04
Sinibuyas	82	11	13.41
Putian	82	0	0

As indicated in Table 2, the results gathered in Experiment 2 tallied with those of Experiment 1. In both cases the Putian

variety proved to be the most resistant to bunchy-top infection. It was at first thought, however, that "disease escaping" might have been involved in this result since infection was left to follow a natural course. To settle this question, the following experiments were conducted by actually inoculating the healthy plants of the Putian variety.

TRANSMISSION EXPERIMENTS

Experiment 1.—This experiment was begun on June 29, 1934, and covered a period of 3 months. This time is considered long enough because in 1931 the senior author reported that the duration of the incubation period (the number of days from the time the aphids are transferred from diseased to healthy plants to the time the first visible symptoms of bunchy-top appear) ranges from about one month to 67 days. This finding corroborates the claim of Ocfemia (1934) that in fast-growing abacá seedlings the incubation period of the disease is 30 to 32 days, and in the slow-growing plants 60 to 72 days. Following the procedure of Ocfemia in his inoculation work, the brown aphids (*Pentalonia nigronervosa* Coq., shown in fig. 1) which had been feeding on abacá plants seriously infected with the bunchy-top disease, were collected and transferred one by one to healthy plants of the Putian variety by means of a home-made abacá fiber brush. The aphids were counted as they were being transferred to the healthy plants, each plant receiving 50 individuals. The senior author in his previous work (1931) on the transmission of abacá bunchy-top disease had also used 50 individuals for every plant in eight series of experiments of 24 potted abacá seedlings and obtained 100 per cent infection under controlled condition in the greenhouse. Again, according to the recent findings of Ocfemia (1934) five aphids from bunchy-top infested abacá are sufficient to transmit the disease to healthy plants. Therefore, by transferring 50 virus-bearing aphids instead of only 5 to every healthy plant every possibility of non-transmission is eliminated. No aphids were placed on the control plants. The results of this experiment are given in Table 3.

FIG. 1. A petiole of the youngest abacá leaf showing numerous aphids, *Pentalonia nigronervosa* Coq. (Natural size).

Photograph by the Bureau of Science, Manila.

TABLE 3.—*Showing inoculation experiments by transferring virus-bearing aphids (Pentalonia nigronervosa) from bunchy-top infested abacá plants to the healthy Putian variety.*

Series of experiments	Inoculated plants	Aphids used	Date of inoculation	Observations				Control plants* used
				Plants infected	Healthy plants	Date 1st symptom appeared	Incubation period in days	
I	4	50	6-29-34	0	4			3
II	2	50	7- 3-34	0	2			2
III	12	50	7- 5-34	0	12			5
IV	10	50	7- 6-34	0	10			5
V	14	50	7- 7-34	1	13	8-9-34	33	7

* Control plants were healthy after the experiment.

Table 3 shows that of the 42 healthy plants inoculated from June 29 to July 7, 1936, only one was infected with bunchy-top, or about 2 per cent infection. This percentage is very small considering the great number of aphids allowed to feed indefinitely on the inoculated plants. Up to this writing the rest of the inoculated plants as well as the control are healthy.

Experiment 2.—On August 10, 1934, another experiment was conducted to confirm the first one. This time the healthy plants of the Putian variety used varied in height from 20 to 150 centimeters, as shown in Table 4. The aphids were counted as in previous experiments. Only 30 individuals were used for every inoculated plant compared with 50 in the previous experiment. The aphids from the diseased plants were allowed to feed indefinitely on the healthy ones. Ocfemia (1930) claims that "the virus-bearing insects required about 48 hours of feeding on healthy plants before they could transmit the disease." Hence, by allowing them to feed indefinitely on healthy plants the chances of transmitting the bunchy-top disease are undoubtedly increased. No aphids were allowed to feed on the check plants. The results of this test are shown in Table 4.

It is of interest to note as shown in Table 4 that three months after the date of inoculation all of the 130 inoculated plants were still healthy. Up to this writing not a single abacá plant among them has shown symptoms of bunchy-top infection. The plants used as control were also healthy.

Experiment 3.—In line with the first two experiments, another experiment was performed December 19, 1934. One hundred sixty healthy plants of the Putian variety, reputed to be bunchy-top-resistant and ranging in height from 20 to 150 centimeters,

TABLE 4.—*Inoculation experiments by transferring virus-bearing aphids (Pentalonia nigronervosa) from bunchy-top infected abacá plants to healthy Putian variety plants of different heights.*

Series of experiments	Inoculated plants	Aphids used	Date of inoculation	Height of inoculated and control plants	Observations*				Control plants
					Plants infected	Healthy plants	Per cent of infection	Incubation period in days	
				cm.					
I	10	30	8–10–34	20	0	10	0		5
II	10	30	8–10–34	30	0	10	0		5
III	10	30	8–17–34	50	0	10	0		4
IV	10	30	8–17–34	60	0	10	0		4
V	10	30	8–17–34	70	0	10	0		4
VI	10	30	8–20–34	80	0	10	0		5
VII	10	30	8–10–34	90	0	10	0		5
VIII	10	30	8–20–34	100	0	10	0		5
IX	10	30	8–21–34	110	0	10	0		4
X	10	30	8–21–34	120	0	10	0		4
XI	10	30	8–21–34	130	0	10	0		6
XII	10	30	8–23–34	140	0	10	0		5
XIII	10	30	8–24–34	150	0	10	0		5

* Both the inoculated and control plants were healthy after the experiments.

were inoculated with the virus-bearing aphids. As previously described, the insects from bunchy-top infected abacá were allowed to feed indefinitely on the healthy Putian variety up to the end of the experiment. Observations were made at regular intervals—once a week for four months—and the data obtained is summarized in Table 5.

TABLE 5.—*Inoculation experiment by allowing the virus-bearing aphids (Pentalonia nigronervosa) to feed indefinitely on healthy plants of the Putian variety.*

Series of experiments	Date of inoculation	Plants inoculated	Observations*		Number of control plants
			Plants infected	Per cent of infection	
I	12–19–34	42	0	0	25
II	12–22–34	30	0	0	10
III	12–28–34	10	0	0	10
IV	1– 1–35	6	0	0	6
V	1– 9–35	15	0	0	12
VI	1–11–35	10	0	0	10
VII	1–16–35	20	0	0	10
VIII	1–21–35	10	0	0	10
IX	1–24–35	10	0	0	10
X	1–25–35	7	0	0	5

* Inoculated and control plants were all healthy after the experiment.

Table 5 again shows that four months after inoculation all 160 inoculated plants were still healthy. The corresponding controlled plants were also healthy.

Experiment 4.—To prove further the resistance of the Putian variety to bunchy-top as well as the virulence or infective nature of the virus, subsequent test was conducted as follows: On July 18, 1935, healthy abacá suckers of about uniform age, vigor, and size were selected from different hills of the Putian and the local Sinibuyas varieties. Between the same date and August 16, 1935, 96 suckers of the Putian and 96 of the Sinibuyas were inoculated as usual by transferring aphids from bunchy-top infected abacá—each inoculated plant receiving 30 individuals from the same batch. The aphids were allowed to feed indefinitely on the inoculated plants to insure the transmission of the disease. The results of the observations made are summarized in Table 6.

TABLE 6.—*Results of inoculation by transferring aphids, Pentalonia nigronervosa Coq., from bunchy-top infected abacá plants to healthy plants of the Putian and Sinibuyas varieties.*

Variety	Date of inoculation	Plants inoculated	Aphids used	Observations		
				Plants infected	Average incubation period in days	Per cent of infection
Putian	July 18–Aug. 16, 1935	96	30	0	0	0
Sinibuyas	do	96	30	20	62.65	20.83

Table 6 shows that in the case of the Putian variety not a single plant out of the 96 suckers inoculated was infected with bunchy-top. On the other hand, of the 96 plants of the Sinibuyas variety that were inoculated at the same time, 20, or 20.83 per cent, succumbed to bunchy-top. This result shows that the virus we were dealing with is virulent. It further proves and confirms the previous array of results that the Putian variety possesses a remarkable degree of resistance to bunchy-top disease. Undoubtedly this quality of resistance as actually proven by repeated artificial inoculation experiments, is inherent in the Putian variety and not merely a case of so-called "disease escaping."

SELECTION AND PROPAGATION OF THE LOCAL VARIETIES THAT SURVIVED THE DISEASE

THE RELATION OF SUBSEQUENT ROGUING AND BURNING OF BUNCHY-TOP INFECTED PLANTS TO REËSTABLISH THE ABACÁ PLANTATION

In 1928, just after the occurrence of the bunchy-top epidemic in Cavite, a general survey was conducted by the senior author to determine the extent of damage wrought by the disease. It was appalling to note that only very few healthy abacá plants survived and remained standing in the infected fields. It was further observed that many abacá plantations had already been converted into "caiñgin" [2] by removing all diseased plants. The healthy stools, however, were spared. From these stools vigorously growing suckers were selected. One hundred fifty suckers of the Sinibuyas variety and another 150 suckers of the Kinalabao variety were planted in our trial plots at the Experiment Station. The Sinibuyas was planted in November, 1928, and the Kinalabao in January, 1929. Periodical observations were made for two years from the date of planting. According to the result of the previous experiment the two local abacá varieties (Sinibuyas and Kinalabao) which were remnants of bunchy-top when planted were not readily attacked by the disease under field conditions obtaining in the station. This preliminary result has thrown, at least, a spark of light on the possibility of reviving the abacá industry in Cavite.

In order to determine whether the resistance of the plants used in the trial planting will continue to prevail in succeeding plantings, some 610 healthy abacá suckers of the Sinibuyas variety were dug up and planted at the Abacá Experiment Station at a distance of 3 by 3 meters each way. Planting was begun on October 2, 1930. Since then, regular row-by-row inspection was made once a month up to the end of the experiment to locate all the abacá plants that showed signs or symptoms of bunchy-top infection. As soon as a diseased hill was located, a big heap of dried abacá leaves and debris was piled on the base and on top of the abacá plant between the petioles of the leaves and then burned. Precautions were always taken to give

[2] "Caiñgin" is a Filipino dialect term for a certain method of farming whereby the big trees and underbrush are cut down and burned and the newly opened land planted to rice, corn, or other short season crops.

the aphids no chance to escape to the neighboring healthy plants. After this preliminary burning the plants including the corms, were dug up, chopped into small pieces right on the same spot and, with the aid of dry combustible materials, burned a second time. The first burning was to kill the aphids; the second to destroy the sources of infection. Whenever burning was impracticable diseased plants were buried deep into the ground. This was done every now and then until the whole plantation was thoroughly surveyed and all diseased plants were removed and properly disposed of. The vacant hills were then replanted with healthy plants.

During the first two years of experimentation, bunchy-top infected abacá plants were occasionally encountered, but they were rogued as fast as they were found. Finally the entire plantation was freed from bunchy-top and the disease was controlled entirely.

On the other hand, in the plot which received no particular attention save partial weeding and general cleaning—where no roguing and burning of diseased plants were attempted—all the abacá plants had almost entirely succumbed to the bunchy-top disease.

From the foregoing test it may be inferred that the resistance to bunchy-top supposedly possessed by the local Sinibuyas variety and which had been manifest in the trial planting had, in some cases, failed to show in the subsequent plantings. Another experiment was conducted in quest of some more definite information on why there were survivors or remnants of the bunchy-top disease and how this phenomenon occurs. The Sinibuyas variety, which has for more than four years been growing vigorously and absolutely free from the bunchy-top disease at Silang Abacá Experiment Station, was used in twenty series of inoculation experiments. These experiments were performed in the open and on different dates with their corresponding control. The first was begun on September 27, 1934, and the last on October 30, 1934. Between these dates 273 hills were inoculated. The same aphids (*Pentalonia nigronervosa*) feeding on bunchy-top infected abacá were used in the inoculation work and the procedure followed was the same as that described elsewhere in this paper. No insects were placed on the control plants. The aphids were allowed to multiply and feed indefinitely on the inoculated plants in order to insure the production of the bunchy-top disease. The results are shown in Table 7.

TABLE 7.—*Result of inoculation by transferring aphids (Pentalonia nigronervosa) from diseased to healthy plants of the Sinibuyas variety that were remnants or survivors of bunchy-top.*

Series of experiments	Inoculated hills	Date of inoculation	Observations				Control plants	Remarks
			Inoculated hills infected	Inoculated hills healthy	Per cent of infection	Incubation period in days		
I	52	9–27–34	12	40	23.07	57	30	Control plants are all healthy.
II	13	9–28–34	1	12	7.69	60	10	Do.
III	16	9–30–34	9	7	56.25	52	14	Do.
IV	10	10– 1–34	1	9	10.00	60	8	Do.
V	15	10– 2–34	6	9	40.00	58	14	Do.
VI	10	10– 3–34	3	7	30.00	50	9	Do.
VII	22	10– 4–34	2	20	9.09	60	18	Do.
VIII	7	10– 5–34	1	6	14.28	60	7	Do.
IX	5	10– 6–34	1	4	20.00	60	5	Do.
X	15	10– 8–34	2	13	13.33	60	13	Do.
XI	15	10– 9–34	2	13	13.33	54	14	Do.
XII	18	10–12–34	2	16	11.11	59	10	Do.
XIII	5	10–13–34	0	5	0	----	5	Inoculated and control plants are healthy.
XIV	15	10–17–34	3	12	20.00	50	13	Control plants are all healthy.
XV	14	10–19–34	2	12	14.28	56	10	Do.
XVI	4	10–23–34	2	2	50.00	55	4	Do.
XVII	14	10–25–34	3	11	21.42	56	13	Do.
XVIII	4	10–27–34	0	4	0	----	4	Inoculated and control plants are healthy.
XIX	10	10–29–34	0	10	0	----	10	Do.
XX	9	10–30–34	2	7	22.22	56	9	Control plants are all healthy.

Table 7 shows that some of the inoculated plants were infected with bunchy-top while some were not infected at all. The highest percentage of infection was obtained from the inoculation work performed on September 30, 1934. In this particular case 16 hills were inoculated and 9 were infected, or 56 per cent infection, 52 days after inoculation. There were three cases, however, where no infection was observed among the inoculated plants. This is best exemplified in three series of inoculation work performed on October 13, 27, and 29, 1934, as shown in Table 7. It is believed that a certain degree of resistance to bunchy-top disease may have existed also among individual

plants of the same variety. Out of 273 hills inoculated only 54 hills were infected, or about 20 per cent. Plants used as control were all healthy. The results show that not all the remnant—or what are generally believed to be survivors of bunchy-top—have developed resistance to the disease. Those that were infected after the inoculation may merely have escaped the insect vectors and thereby missed the disease. Perhaps this is a good example of the so-called "disease-escaping." On the other hand, those that withstood bunchy-top infection even after they received a heavy dose of the inoculum might be strains that are really resistant to the disease.

One of the diseased abacá hills of the Sinibuyas variety that yielded to bunchy-top infection after inoculation is illustrated in Plate 2, fig. 1. Plate 3 shows one of the healthy abacá hills of the local Sinibuyas variety that withstood bunchy-top infection after inoculation, or the so-called survivor of bunchy-top disease.

SUMMARY

1. This paper presents a further study on the possibility of reëstablishing the abacá plantations in Cavite Province which were previously wiped out by the bunchy-top disease. The methods employed are: (*a*) selection and propagation of highly resistant introduced varieties that showed at least a marked capacity to withstand bunchy-top infection, (*b*) selection and propagation of the local varieties that survived the disease, and (*c*) constant roguing of all diseased plants and replanting the vacant hills with healthy abacá suckers or rootstocks.

2. The possibility of rehabilitating the abacá industry in Cavite has been demonstrated by planting the introduced Putian variety. After about six years of continuous observation and experimentation under natural field conditions and by inoculation experiments this particular variety has proved highly resistant to the bunchy-top disease.

3. It has been shown that the relative resistance of local Sinibuyas and Kinalabao varieties that were remnants or survivors of the bunchy-top disease is not permanent. Some of them have survived because they merely escaped the disease. However, they may be planted in places where bunchy-top has completely disappeared, provided the suckers or rootstocks are absolutely healthy and taken from disease-free stools. This should be supplemented by very close vigilance and periodical supervision of the plantation.

4. Constant roguing and burning of diseased plants and replanting the vacant fields with healthy ones have given very satisfactory results in the rehabilitation of the abacá industry at Silang Experiment Station, Cavite Province.

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ILLUSTRATIONS

(Photographs by the Bureau of Science)

PLATE 1

A hill of abacá (Putian variety) highly resistant to bunchy-top disease as actually proven by repeated inoculation experiments. The number and size of the stalks as well as the good stand of the plants should be compared with the local Sinibuyas variety on Plate 3. Age of the plant, 7 years, 1 month, and 10 days.

PLATE 2

FIG. 1. A hill of abacá (Sinibuyas variety) artificially inoculated with the aphids from bunchy-top infected plants. It is seriously infected with the bunchy-top disease.

2. One of the introduced varieties of abacá (Maguindanao variety) at Silang Experiment Station, highly susceptible to bunchy-top disease.

PLATE 3

A healthy hill of abacá of the local Sinibuyas variety that withstood bunchy-top infection after inoculation or the so-called remnant or survivor of the bunchy-top disease. Age of the plant 5 years, 6 months, and 1 day.

TEXT FIGURE

FIG. 1. A petiole of the youngest abacá leaf showing numerous aphids, *Pentalonia nigronervosa* Coq. (Natural size.)

PLATE 1.

1

2

PLATE 2.

PLATE 3.

CHEMICAL STUDIES ON CASSAVA PRODUCTS, I. THE CRITICAL MOISTURE-MOLDING CONTENT OF CASSAVA STARCH

By SEVERINO B. ETORMA

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ONE TEXT FIGURE

It has been claimed that micro-biological chemistry is the chemistry of the future. Molds have become so important in many industrial establishments that they are harnessed to do the work of the chemists in 24 hour-shifts if given the right kind of food, protection from their enemies, and a physical environment generally favorable for their metabolism. The employer will not be troubled by strikes, walk-outs, black lists, or turn-overs if he employs molds for the fabrication of his products(1).

Conversely, molds do a lot of damage to industrial products such as starch, textiles, paper, oil, sugar, etc., if the preparation of these products is not well controlled.

The object of this study is twofold—to determine the critical moisture-molding content of cassava starch and the rate of absorption or loss of moisture in response to modified atmospheres. The importance of the work lies in the fact that under local conditions, where the humidity is rather higher than in other countries, storage of cassava starch for long periods may become a problem in the future, with the development of the cassava-starch industry. The high relative humidity of the air will undoubtedly result in increased moisture content of the starch and thus promote its saccharification by molds like *Aspergillus niger, Aspergillus oryzae, Amylomyces rouxii, Chemydo-mucor oryzae, Rhizopus oryzae,* and *Mucor alternans,* as found by Levy(2).

Studies on similar subject under local conditions in the past were undertaken in the case of copra by Lava(3). He found that the critical molding-moisture content of ground copra under an external average relative humidity of 81 per cent and ordinary room temperature was 8 per cent.

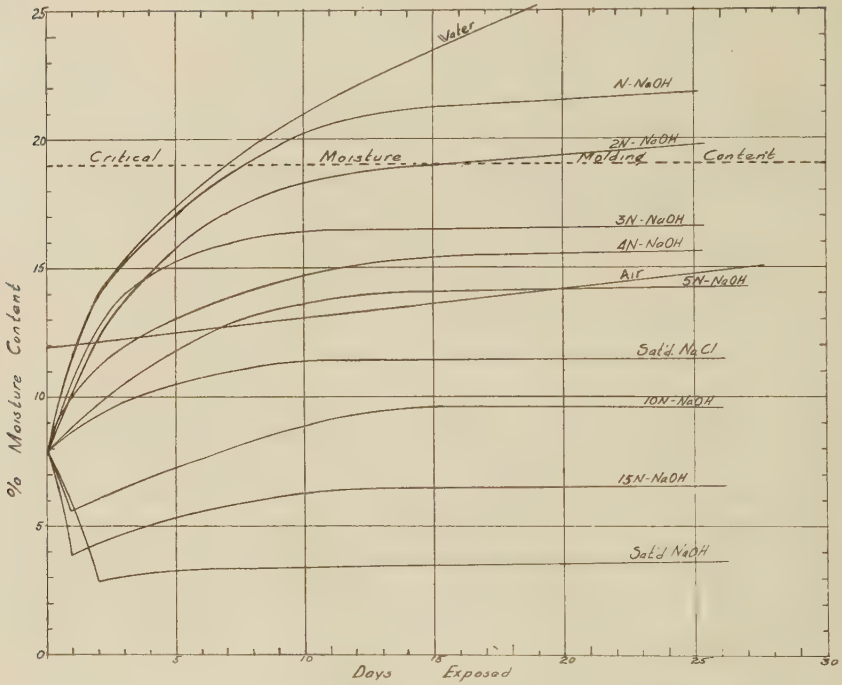

FIG. 1. Behaviour of cassava starch in modified atmospheres

EXPERIMENTAL METHODS AND RESULTS

Working on the basis that different concentrations of electrolytes in a closed chamber will maintain a certain relative humidity at a certain temperature owing to each particular surface tension, the writer used covered museum jars as containers(4). The jars were provided with 500 cc. of water and an equal volume of solutions of 1 Normal 2N, 3N, 4N, 5N, 10N, 15N, saturated sodium hydroxide, and saturated sodium chloride. They were then covered with glass plates and stuffed at the point of contact between the mouths of the jar and the lids with vaseline to make them air-tight. The initial moisture content of the starch studied was 7.82 per cent. Samples were placed on petri dishes and subjected to the action of moisture under different modified atmospheres after inoculation with cultures of the *Aspergillus oryzae-flavus* group of molds. There were 11 treatments, in the open air, over water, and over 1N, 2N, 3N, 4N, 5N, 10N, 15N, saturated sodium hydroxide and saturated sodium chloride solutions. Periodic determinations of moisture were made, the results of which will be found in table 1. In order

to interpret clearly the results of the determinations the percentages of moisture found in the samples at different intervals covered by 76 days was plotted as shown in Fig. 1. A horizontal line parallel to the X-axis was drawn at the point where the initial mold growth was observed. A rise above this line, which indicates a moisture content of cassava starch above 19 per cent, indicates increased growth of destructive molds.

TABLE 1.—*Moisture content, at periodic intervals, of cassava starch subjected to different atmospheres*

INITIAL MOISTURE CONTENT—7.82 PER CENT

Days	Open		Sodium hydroxide							*Saturated*	*Saturated* NaCl
	Air	Water	1 N	2 N	3 N	4 N	5 N	10 N	15 N		
1	11.98	11.18	11.69	10.52	9.09	9.01	8.53	5.63	3.94	3.79	9.36
2	12.72	14.07	14.22	12.74	12.65	11.22	9.78	7.11	4.29	2.80	9.30
4	12.60	15.88	16.09	13.82	13.69	12.48	10.78	6.78	4.77	2.35	9.01
5	11.79	15.77	17.21	16.93	15.92	13.69	12.99	9.71	7.01	3.96	12.89
6	10.60	18.88	19.89	13.14	15.84	14.96	13.85	9.86	5.88	4.16	11.52
7	14.22	20.26	19.76	17.51	16.67	15.27	13.83	9.70	7.28	4.69	12.39
8	12.86	19.62	19.47	16.42	------	14.34	13.12	------	4.59	3.29	11.15
9	13.70	20.42	19.35	17.73	16.36	14.46	13.24	8.56	6.13	3.37	11.37
11	13.12	20.96	20.69	16.78	16.11	14.07	12.87	8.17	5.32	2.58	10.81
15	13.60	23.29	21.21	18.97	16.13	14.81	13.68	9.67	6.45	3.31	11.94
18	14.65	25.26	22.30	19.16	16.78	16.18	14.29	9.78	6.40	3.53	11.92
19	13.97	30.93	25.02	19.74	17.03	14.59	14.12	9.54	5.95	3.71	12.61
33	15.99	[a]	23.11	19.21	16.41	15.56	13.98	8.98	6.32	2.86	11.52
76	15.78	[a]	[a]	20.06	16.56	16.03	14.38	9.89	6.55	4.69	13.75

[a] Spoiled samples moisture content in bold types have mold growths.

All samples inoculated with spores of black and yellow molds.

SUMMARY

(1) The curves representing the rates of absorption or loss of moisture show that the modified atmosphere where the moisture content of the starch and that of the former come to an equilibrium which is attained at the end of 15 days, after which period such behaviour proceeds slowly.

(2) The rate of absorption by or loss of moisture in cassava starch under different atmospheres is very variable as shown by curves of straight line in air, parabolic in water and in less concentrated solutions of sodium hydroxide and concentrated solution of sodium chloride, and asymptotic in more concentrated solutions of sodium hydroxide.

(3) The critical moisture molding content of cassava starch was found to be 19 per cent. It is, for that reason, recommended that cassava starch, to be kept free from mold growth, should be dried much below 19 per cent of moisture.

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RICE HYBRIDS *VERSUS* STEM ROT DISEASE

By GAUDENCIO M. REYES

Of the Bureau of Plant Industry

THREE PLATES

The stem rot of rice ascribed to *Sclerotium oryzae* Cattaneo (Plate 1) is a common disease, and constitutes as one of the principal limiting factors in rice production in many parts of the Philippines. It constantly menaces the profitable production of rice causing heavy losses at times. Fortunately it has been found so far to attack only rice under lowland conditions and its occurrence is restricted by weather conditions.

As a measure of waging warfare against the pernicious activities of this disease, the most feasible means which seems to give the greatest promise, especially in thoroughly-infested soil, is the planting of resistant varieties. In an effort to diminish to some extent the depredations of this disease, an attempt was made to determine by field experiments the differences in reaction to stem rot disease of certain newly-created rice hybrids [1] developed by the former Bureau of Agriculture at Alabang, Rizal. Fortunately, in these crosses, the factors of resistance and commercial qualities were incidentally combined and some of the results seem to suit the local requirements.

One of these rice hybrids is what is now known as Raminad Str. 3, a product of a cross between Ramay ♀ and Inadhica ♂. In reality it is the outcome of a long process of elimination and selection of a hybrid chosen from several types which manifested themselves distinctly in the second and third generations, not only for disease resistance but also for other desirable characters. One of these hybrid daughter plants (28.15–1–35–1–), better known as Raminad Str. 3, was isolated by the writer for having bred true to type and for showing moderately high resistance to the rice stem rot caused by *Sclerotium oryzae*, to which Ramay is resistant and Inadhica is very susceptible under natural or artificial conditions of exposure.[2] But besides being

[1] Results of crosses performed in 1928 and 1929 by Dr. J. P. Torres and Mr. B. R. Bautista, plant breeder and assistant agronomist, respectively, of the defunct Alabang Rice Station.

[2] Reyes, Gaudencio M. A preliminary report on the stem rot of rice. Philip. Agric. Rev. 22: 313–331. 1929.

resistant to the rice stem rot, the value of Raminad Str. 3 is enhanced by manifesting also considerable resistance to the brown linear spot (*Cercospora oryzae* Miy.), a common disease although of comparatively lesser economic importance, to which the male parent sort, Inadhica, is extremely susceptible and the female somewhat resistant.

This hybrid selection is also outstanding for its high productive ability (Plate 2), although it has not consistently outyielded Ramay, an exotic variety which is widely known for its prolificacy, though not very desirable from certain agronomic, commercial and biologic standpoints, exhibiting an unfortunate dissociation of the factors of resistance and good qualities. In quality this hybrid segregate may be compared favorably with Inadhica, a susceptible but highly desirable commercial variety. This selection possesses a distinct type of grain, carrying a combination of features of its female and male parent varieties (Plate 3), and the size of the kernel is intermediate between broad and slender characters, approaching somewhat closely that of Elon-elon (Plate 3), a variety whose kernel is considered incomparably superior in quality in the local market. Thus a close association of the two factors, resistance and yield, is here exemplified. Another interesting result of this hybrid segregate is that the late-maturing character of its resistant female parent variety was reduced by about two weeks which is considered quite a significant improvement.

The inheritance of resistance in this case is not at all strange and it appears evident that increased resistance was obtained in certain hybrid progenies in disease resistance experiments conducted. Further tests along this direction was continued although not in succession because the work had to be suspended owing to the Government reorganization and centralization of functions. A detailed report on the reaction of new hybrid segregates to artificial infection under partially-controlled conditions with *Sclerotium oryzae* [3] will appear later in an issue of this Journal. Suffice it to state for the present that of the rice hybrids that have proved reasonably resistant thus far, Ramay x Inadhica Str. 3 and Elon-elon x Inadhica Str. 3, are worth mentioning.

It might not be amiss to state in this connection, that in recognition of the excellent field performance and commendable resistance of this hybrid segregate (Ramay x Inadhica Str. 3)

[3] A progress report was read in the Bureau of Plant Industry Seminar held on October 9, 1936.

to stem rot of rice which had been observed by interested persons, including the assistant plant breeder, Mr. Juan O. Unite and the Acting Superintendent, Mr. Basilio R. Bautista of the former Alabang Rice Station, in the writer's experimental field at the Alabang Stock Farm, Rizal, these officials deemed it worthy to propagate all the seeds the writer turned over to them for future distribution to the farmers. The name "Raminad" [4] was proposed by the writer, following conventional or established rules of nomenclature. Accordingly the hybrid of Elon-elon x Inadhica is named "Eloninad". Bu once a resistant variety or hybrid strain has been evolved, it devolves upon those who handle it to make sure that the seeds are kept scrupulously pure, because even the admixture of a single seed is sufficient to decrease its economic value. That this particular hybrid strain possesses sufficient market qualities and important agronomic features, as well as a desirable character from a phytopathological viewpoint, is attested by the fact that in recognition of its excellent behavior, efforts have been made to extend its cultivation,[5] as it is immensely profitable for planting in areas easily subject to stem rot infection.

To dispense with all profit-cutting control measures, the use of resistant varieties seems to be the ultimate solution. But since the commercial varieties tested so far have all shown varying degrees of liability to stem rot attack and those found resistant were undesirable in certain respects, the ameliorative efforts of plant breeders to deliberately combine, by systematic crossing, the character of disease-resistance of one variety with highly desirable commercial or agronomic qualities of another variety, would seem the last recourse as the effort is fraught with abundant possibilities.

Raminad Str. 3 is a resistant segregate of Ramay x Inadhica, and is considered the best strain after the gradual elimination of the poorer strains, offering moderate improvement and complimentary resistance over the original parentage.

The results obtained thus far give us hope to predict that in the near future there may be obtained eventually for distribution to the farmers more superior varieties synthesized with all the desirable qualities blended and fixed.

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[4] Reyes, G. M. A report on the status of selection of hybrid segregates for resistance to *Sclerotium oryzae* Catt. December, 1931 (Unpublished).

[5] Anonymous. Bureau produces new rice strain. The Philippines Herald, July 13, 1936, p. 3.

ILLUSTRATIONS

(Photographed by the Bureau of Science.)

PLATE 1

An enlarged portion of a rice stem infected with *Sclerotium oryzae,* cut longitudinally to show the presence of black, shiny, spherical sclerotial bodies and the discoloration of the inner tissues. Approximately $\times 3$.

PLATE 2

A plat of the F_3 generation hybrid, Ramay x Inadhica Str. 3, which exhibited high productivity and a little appreciable injury due to stem rot attack.

PLATE 3

Greatly enlarged grains and kernels of Ramay x Inadhica Str. 3, compared with those of the parent varieties and with the extra superior Elon-elon. Note carefully the inheritance of grain characters. Approximately $\times 1.72$.

PLATE I

PLATE 2.

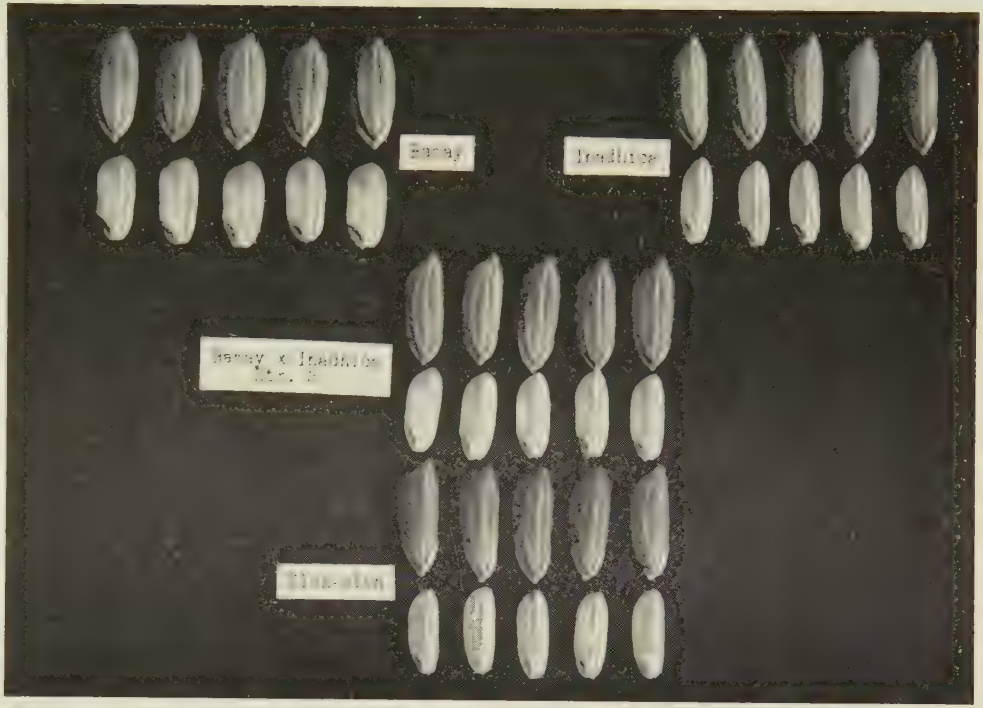

PLATE 3.

NOTES ON A CACAO POD BORER MOTH *ACROCERCOPS CRAMERELLA* SNELL.

By F. Q. Otanes

Assistant Chief, Plant Pest and Disease Control Division

TWO PLATES

Cacao is one of the crops the extensive growing of which is being encouraged in the Philippines in order to meet not only the local demand for the beans but also for export. At present the country still imports annually about half a million pesos worth of cacao beans from other countries, principally from the British and Dutch East Indies. Accordingly, it is important that due attention be given to the plant pests and diseases of cacao.

Judging from its work in a number of localities, a small caterpillar which bores into the pods of cacao bids fair to be a pest of no little economic importance in the cultivation of cacao. The adult is a small moth of the genus *Acrocercops*. The insect was definitely identified by Dr. P. v. d. Goot of the Institute for Plant Diseases in Java as *Acrocercops cramerella* Snell, from specimens sent by the Bureau of Plant Industry to Dr. K. W. Dammerman, Buitenzorg, Java, in 1934. The insect is a serious pest of cacao in Java, and Dammerman (1929) reported that the species was not known outside of Java. There has not been any report in the Philippines on any other species of the genus destructive to cacao. There is another member of the genus, *Acrocercops* sp., but its host plant is *Caesalpinia pulcherrima*, a legume. This other species is parasitized by *Elasmus albomaculatus* Gahan (1920).

The writer first had the opportunity of observing the work of the insect in the field in May, 1932, at Mulig, Davao, and again during May and June, 1936, in both cases while he was on locust campaign work. So far as records show, Mulig, Davao, is the first locality in the Philippines where the pest was reported serious. Subsequently it was reported from northwestern Cotabato, Zamboanga, Occidental Misamis, Cebu and Batangas, by the district and provincial agronomists concerned.

It thus appears that the insect is not as localized as was first supposed. In Davao it is somewhat widespread and is serious, as high as 90 per cent of the pods in the cacao growing districts, especially in the Malita district, being usually destroyed, according to a report submitted by Bonifacio Padilla, acting provincial agronomist.

LIFE HISTORY, HABITS AND DESCRIPTIONS

According to Dammerman (1929) the moth is seldom seen, being on the wing only at night. It is a very delicate insect with a wing expanse of 12 millimeters, the forewings having many white cross lines and yellow spots at the tip. The eggs are laid singly on the cacao pods and the caterpillars bore through the shell and make long galleries between the seeds, filled with excreta and frass, so that the quality of the product is very much reduced. In Java, according to Dammerman, the total life cycle is about four weeks, the life of the adults lasting not more than one week.

The adult is a dark gray moth and is about seven millimeters long. The forewings are with more or less oblique narrow white cross lines or stripes and the apical portions are mostly orange yellow. The legs and antennæ are rather long, considering the size of the insect.

The caterpillars spend most of their life within the cacao pods, causing the latter to decay and rendering them useless. The caterpillars are about a centimeter long, usually pale green and a little over a millimeter wide. They emerge from the pods, and the holes thus made, the borders of which later become blackish, constitute one of the evident indications of the presence of the pest in an orchard or in a plantation.

The cocoons are brown, flat and the threads are so fine and so closely woven that it is rather difficult for water to pass through. It is transparent, so that the pupa is visible inside. The pupa is about 7 millimeters long and is light green in color, turning dark when the adult is about to emerge. Cocoons have been observed on cacao fruits and on the leaves. Some have also been collected from dried leaves on the ground.

CONTROL

The following from Dammerman about *Acrocercops* (*Zaratha*) *cramerella* Sn., is here quoted, as the control measure employed in Java may be of interest and of value in the Philippines,

pending detailed studies on the life history and habits of the insect and its control here:

"Infestation of the plantation by moths from elsewhere takes place to a less extent than is generally believed, and is always inconsiderable compared with the infestation arising from the gardens themselves; anyhow the danger may be reduced by protecting the plantation by a natural fence of high trees. The extermination in the neighborhood of the cacao plantation of native-grown cocoa, cola and fruit-trees, which are liable to attack by the cocoa moth, is advisable but seldom practicable.

"Of the direct control measures the 'rampas' method, first advocated by Zenthner, may still give the best results. The rampas method (the Malay word 'rampas' means to take away by force) consists in taking care that at a certain moment there are no fruits in the plantation or only very small ones which are free from infestation. All fruits of 5 cm. in length or more must be removed; the shell should be buried immediately; after a week they may be used, however, as manure. The best time to carry out the operation of the rampas is the end of the harvest, when a sufficient flowering and first setting occurs. Separate work-gangs go round the gardens two or three times and remove all the older fruits; after two or three weeks the gardens are again gone over in order to ensure that no pods are left behind. If there is only one harvest annually, the rampas is performed only once but in plantations that are harvested twice a year it is better to do it twice. The method can be performed effectively only when there is sufficient space between the plants, the pruning is properly done and there are no catch crops. The measure should be practised at the same time in neighbouring cocoa plantations; if this is impossible the surrounding of the plantation by some other crop is advisable. Furthermore, rapid harvesting is recommended; the gathering of the pods should be finished within two to three months.

"Plant selection may also help; cacao pods with a hard shell and a smooth skin are less attacked; the 'djatiroenggo' hybrid is far less injured by the cacao moth than the criollo variety, and the latter is gradually being replaced by the former on this account."

It has been stated that cocoons have been collected from the fallen leaves of cacao. It would thus be a good practice to gather the fallen leaves regularly and burn them in order to destroy the pupæ.

All badly infested pods, including those that fall down, should be collected and burned or buried and later used as manure, as is done in Java. Some such system as the "rampas" method, which is practised in Java, as has been described, may be adopted if found advisable, after a study has been made concerning the cacao-moth-borer situation in the locality concerned. At any rate, it would be a good policy to prevail on all cacao planters to keep their plantations clean, that is, burn or properly dispose all fallen leaves and cacao pods on time in order to destroy the larvæ and pupæ. If an ordinance is needed to this effect, its passage may be justified.

Resistant varieties of cacao, if any, should be given preference for planting, all things being equal, as is being practised in Java.

So far, no natural enemies have been observed on specimens reared in the laboratory at Singalong, Manila, at various times. In Java, Dammerman states that in 1912 some parasites were detected for the first time by Roepke; namely, *Diaglyptidea roepki* Vier., *Photoptera erythronata* Vier. and a species of *Mesostenus*, the last being the most common. He adds that these ichneumonids develop inside the cocoons of the moth and that they have recently changed their host as they are more commonly found in the egg sacs of spiders. The propagation of the parasites, according to him, was tried but was only partly successful.

The egg parasite, *Trichogramma minutum*, introduced by Dr. Gonzalo Merino, Chief of Plant Pest and Disease Control, from the United States is being tried on the eggs.

Spraying with lead arsenate or other arsenicals or with suitable miscible oils impregnated with a substance that is toxic or repulsive to the young larvæ (so few or none will bore into the fruits) may be of some value and should be thoroughly investigated.

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ILLUSTRATIONS

PLATE 1

The cacao pod borer moth, *Acrocercops cramerella* Snell., showing:

1. Full grown caterpillar, about 8 ×.
2. Pupa, about 8 ×.
3. Adult, about 8 ×.
4. Anterior (*a*) and posterior (*b*) wings, enlarged.

PLATE 2

Portions of an infested cacao pod showing:

1. A caterpillar.
2. Cocoons.

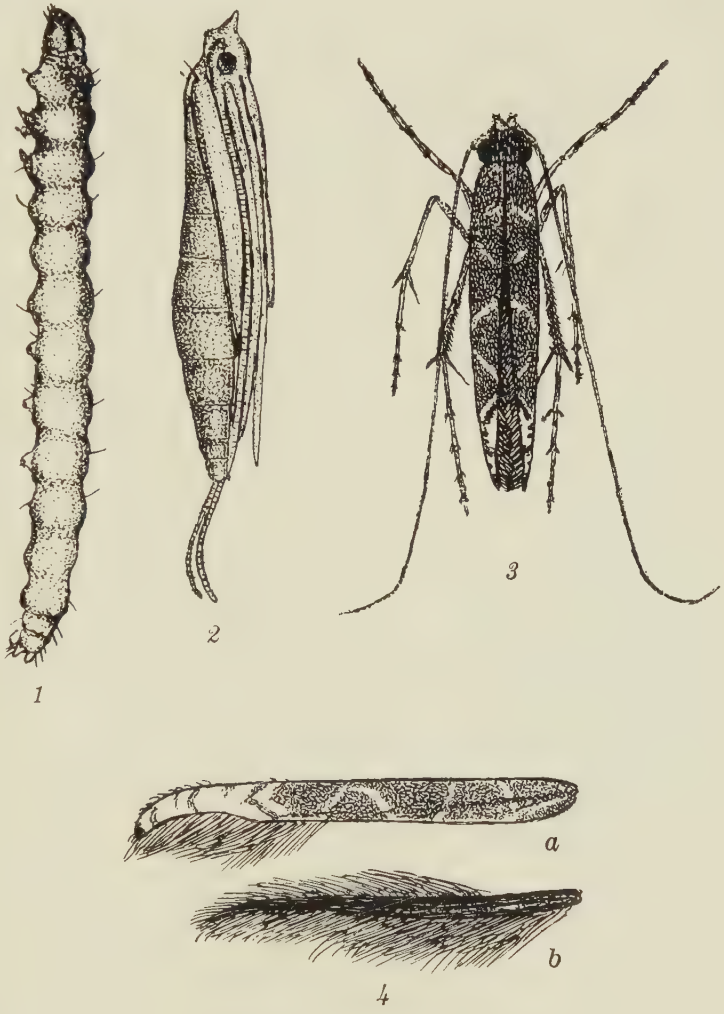


PLATE 1.

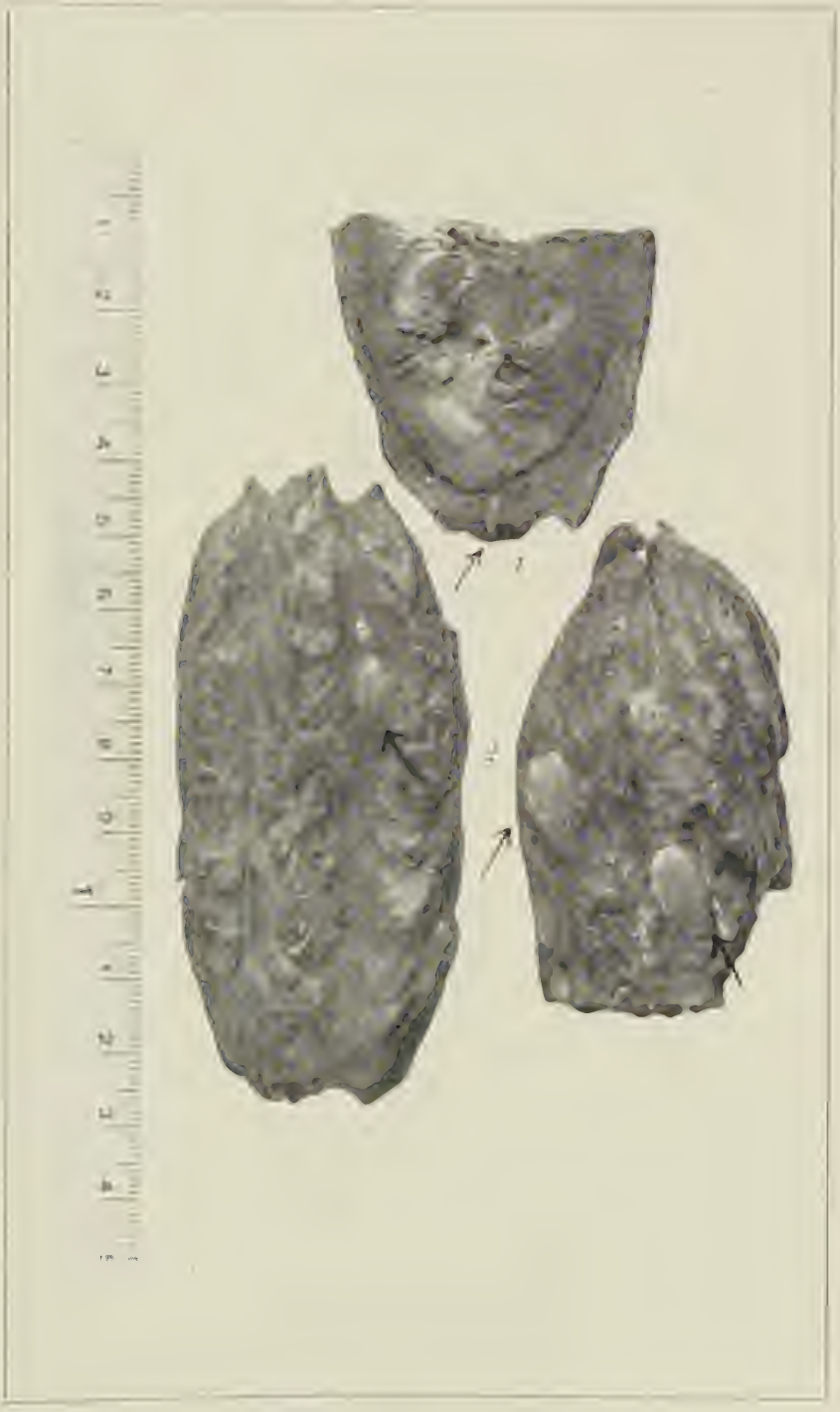


PLATE 2.

NOTES ON THE POSSIBILITY OF CAULIFLOWER SEED PRODUCTION IN THE PHILIPPINES

By M. E. Gutierrez

Of the Bureau of Plant Industry

ONE PLATE

In line with the plan of crop diversification initiated by Dr. Manuel L. Roxas, former Director of Plant Industry, several new crops were tried in this country and found adaptable, not only with reference to our climatic and soil conditions, but also to the cultivated taste for new foods of the Filipinos. Among these new-comers, mention is made of Bermuda onion and Indian cauliflower—crops that are coming to stay. The varieties of these crops, which gave successful results, were specific and generally of tropical adaptation. In other words, they were sorts developed for the tropics. Among cauliflower varieties remarkably successful cultures were obtained with Early Patna [1] and early Benares [2] whose seeds are imported from India and handled by the famous seed house, Sutton and Sons.

Cauliflower is considered a table delicacy of the vegetable realm, and therefore the marketable flowers or "curd" fetch fancy prices. While it belongs to the genus *Brassica,* which includes the common cabbage and the less common table delicacies, broccoli and Brussels Sprouts, cauliflower tops them all in the cost of seeds. Cauliflower seed is twelve to fourteen times more costly than the seeds of cabbage, as any seed catalog may amply testify.

Let it be said for the Filipinos, and incidentally bearing on the future of cauliflower in this country, that although formerly no cauliflower was grown here, they were already acquainted with the use of frozen cauliflower sold at the cold stores, espe-

[1] Rodrigo, P. A., P. S. Urbanes and P. Henares. A progress report on the acclimatization of cauliflower, 1933–1934. Phil. Jour. Agr. 6 (1935) 115–127.

[2] Rodrigo, P. A. Annual report on vegetable research ending November 15, 1935, submitted to the Director, Bureau of Plant Industry, Manila (unpublished).

cially the cauliflower component of sour and sweet pickles obtainable from all groceries. With locally grown cauliflower and with lower prices, a greater amount of that produce will be consumed. Not only pickles are made from it now, but the people are learning rapidly other ways of preparing appetizing dishes from the home-grown product.

The prediction that cauliflower is coming to stay cannot be taken as gospel truth as yet, because in the lowlands, where it is successfully grown, it cannot be coaxed to produce seeds for the next crop, an important factor in the establishment of a permanent foothold in this country. The Bureau of Plant Industry shoulders the task of importing the seed from abroad and distributing it at cost to interested growers. The prohibitive cost of the seed, however, has seriously interfered with the further extension of hectarage planted to cauliflower.

Is the country totally incapable of producing this costly cauliflower seed? Rodrigo et al.[2] reported that Early Patna flowered and produced pods freely in Manila (sea level) but never produced seeds, while in Lipa (1,050 feet above sea level) a few seeds were produced that, when planted in Manila, produced the edible "curd." Investigation is still going on this subject. The present paper presents some data that are believed to be important leads for producing Philippine cauliflower seed. These leads were discovered at the Baguio Semi-temperate Fruit Station, now the Baguio Plant Industry Experiment Station, Baguio, in the 1935–36 vegetable season. Baguio, the vacation resort, is in the highlands, 5,000 feet above sea level, with cool and salubrious climate bordering on the temperate. Temperate flowers and vegetables, recalcitrant in the warm lowlands, thrive here, of course, under intensive culture. Baguio, therefore, can grow the temperate varieties of cauliflower, like Snowball and others, for the market, just as the Indian cauliflowers prefer the lowlands for their best development. This is one of those happy coincidences that in the compass of the same country, a certain region like the lowlands produces a type of marketable cauliflower, while another region may provide the planting material of that crop, which fact will redound to the better economics of the new industry. The conditions for reproduction required by the Indian cauliflowers may be better satisfied at the high-

[2] Rodrigo, P. A. Annual report on vegetable research ending November 15, 1935, submitted to the Director, Bureau of Plant Industry, Manila (unpublished).

lands with climatic conditions like those of Baguio than in the warm lowlands, hence the readier response to seed, than to "curd" production.

When more serious and extensive trials for seed production are undertaken, the seed locally grown will give the same quality of product as that obtained from the imported seed, then the prediction that cauliflower culture will stay in this country will be an accomplished fact.

Some preliminary data are given here to throw light on the future prospects of the seeding of cauliflower.

Seeds of Early Benares and Early Patna were sown on November 11, 1935, in seedbeds, 1.2 by 10 meters. These beds had sloping covers of grass. The seeds were not sown under low but long glasshouses, due to the lack of these, as is the universal practice here for rearing good and strong vegetable seedlings for transplanting.

On January 15, 1936, half of an ordinary garden bed, in conjunction with a home garden demonstration plot, was planted to seedlings of Early Benares, spaced 50 centimeters each way. This garden plot was previously fertilized with a locally mixed fertilizer of the composition 10 N–15 P205–8 K20 at the rate of 800 kilos per hectare. In order to improve the vegetable matter of the soil, old lumbang meal, in lieu of compost, was applied at the rate of one ton per hectare. In order to correct the acidity of the soil, the same amount of lime as the rate of the lumbang meal was also applied.

In March of the same year the early Benares flowered, but the "curd" was very small and therefore unmarketable. The tendency of the flower inflorescence to elongate rapidly with flowers opening and pods issuing forth was so manifest, and therefore hope for seeding was entertained. A view of the plants in bloom and with pods appears in Plate 1 (1).

As with most of our vegetables growing during the same season, insect pests were very serious, and in spite of weekly sprayings with solutions of Imazu insect powder and lead arsenate, our crops could not be totally freed from them. Some of the cauliflower pods were damaged by the pests and irretrievably lost for seed.

The Early Patna planting in another field with our cabbage cultures, while showing precisely the same tendency at seed production, fared worse than the Early Benares with regard to the pests, and the work was discontinued.

Of the 13 Early Benares plants, which eventually produced seeds and harvested in April, the following results were obtained:

TABLE 1.—*Variation in pod and seed production of Early Benares cauliflower*

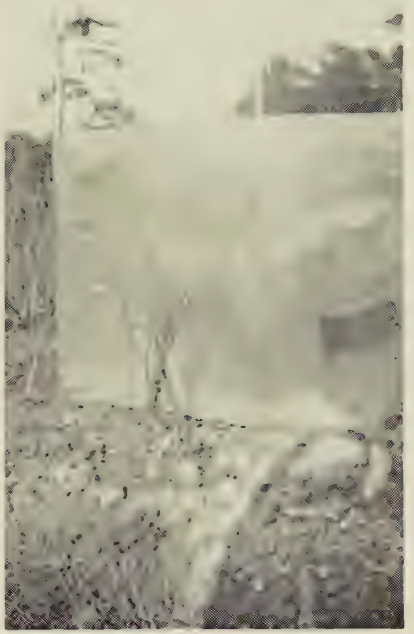
Plant No.	Pods per plant	Seeds per plant
1	6	34
2	17	96
3	77	210
4	103	682
5	93	452
6	56	245
7	76	237
8	12	33
9	25	88
10	23	45
11	4	15
12	18	86
13	11	18
Totals	521	2,241

Average number of pods per plant ..... 40 ± 0.205
Average number of seeds per plant ..... 172.4± 0.336

The records show a wide variation in the pod and seed production of the plants. Plant No. 11 produced only 4 pods with 15 seeds, whereas Plant No. 4 produced 103 pods with 682 seeds, about 26 times more pods and about 46 times more seeds than No. 11. This very wide variation in a very small plant population is a very hopeful sign of the possibilities of seed production. On the average, however, the plants produced 40 ± 0.205 pods and 172.3 + 0.336 seeds each (see Plate 1–2).

It seems, therefore, very probable in the light of these initial results, that should a serious and large cauliflower seed production be undertaken of the varieties successfully grown in the lowlands, this country may become self-sufficient in this nascent cauliflower industry; the highlands with similar or higher altitude than Baguio, Mountain Province, may produce all the seeds required in the lowlands, which in turn, may grow all the cauliflower for home consumption.

1



2

PLATE 1.

ILLUSTRATION

PLATE 1

FIG. 1. A view of Early Benares cauliflower plants in bloom and pods.
2. An Early Benares plant with many pods.

QUARTERLY NOTES

FAWCETT, HOWARD S.—Citrus Diseases and their Control. 2nd ed. XXI + 656 pp., 187 fig. McGraw-Hill Book Co., Inc. New York and London, 1936. ₱6.

Professor Fawcett is indisputably the leading authority on citrus diseases. His latest revised book on citrus diseases and their control is an example of what could be accomplished with the mass of accumulated knowledge on the diseases of other economic plants. The book includes a treatise of the entire field of citrus diseases, divided into four main parts.

The first part consists of eight chapters. This part is devoted to the general consideration of the history of citrus-diseases investigation, species and varieties of citrus, classes of diseases, classification and distribution of fungi, factors affecting virulence, general principles on prevention and treatment, chemicals, and cultural practices in relation to citrus diseases.

In the second, third, and fourth parts, a systematic grouping of diseases is accomplished. The diseases of citrus are classified into three main groups according to their occurrence on the three parts of the tree. A key is provided for each group or class of disease. Accordingly, the second part consists of a treatise on root and trunk diseases; the third part, diseases of branches, twigs and leaves; and the fourth part, fruit diseases. This arrangement is conducive to a simpler understanding and facilitates the use of the book by citrus orchardists, investigators and students. Professor Fawcett has put together the much needed information from the earliest to the last on citrus diseases. Investigators, students and citrus orchardists will find this book an invaluable guide and reference. The book is not a mere compilation, for Professor Fawcett is a ripened master of the subject, and his collaborators are all specialists.

Students in plant pathology will be greatly benefited in their studies on citrus diseases by the use of this book, while investigators on citrus diseases will be greatly aided in this field of investigation. Orchardists will find abundant information accumulated as the result of years of study. There are over 180 illustrations in the text figures, some of which are colored. A bibliographic list of over one thousand references, some of which are useful guides to other literatures on the subject, are included.—FELICIANO M. CLARA.

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